The scientists also found that heart rate variability decreased with increasing mercury exposures, particularly in boys in the 1–10 µg/L exposure range. Grandjean explains, "The heart rate must vary in accordance with the varying needs for oxygen of the peripheral tissues. This variation is regulated through the autonomic nervous system. A decreased variability is a sign of abnormality, as the heart then is slower in responding to the body needs."

The *Epidemiology* findings are especially interesting from a public health perspective because childhood blood pressure has been shown to be an important predictor for hypertension later in life. The findings also indicate that prenatal exposure to methylmercury at concentrations below current exposure limits can cause adverse health effects. The daily intake reference dose of the U.S. Environmental Protection Agency is 0.1 µg/kg body weight per day, an intake that Grandjean says would correspond to mercury concentrations of about 5 µg/L in cord blood and about 1 µg/g in hair.

In a related study (not funded by the NIEHS), that was published in the July/August 1999 issue of *Neurotoxicology and Teratology*, Grandjean and colleagues examined 149 children on the island of Madeira, off the coast of Morocco. The Madeiran children were exposed to methylmercury when their mothers ate the deep-sea fish black scabbard while pregnant.

The children's hair mercury concentration at the time of the test was measured to determine current exposure level. Hair samples were also collected from the mothers, with the hair of those whose diet hadn't changed over the past seven years (some 80% of the mothers) serving as an indicator of methylmercury exposure at the time of pregnancy.

The children then underwent neuropsychological and neurophysiological testing, including assessment of evoked potentials (electrical signals from the brain that are evoked by sensory stimuli). The results of prenatal exposure would logically be linked to the maternal hair mercury concentrations, which in the Madeiran cohort were found to vary from 1.1 to 54.1 µg/g. The scientists found that certain evoked potentials tended to be slower in children who had been exposed to higher concentrations of mercury. According to the report, children of mothers with hair mercury concentrations higher than 10 µg/g experienced delays of as much as 10% in auditory and visual latencies. Says Grandjean, "[Evoked potentials] represent an objective assessment of nervous system function, and they are relatively independent of confounders. They therefore provide support for the observations of neuropsychological deficits previously reported. The clinical implications of these findings, in total, is that children with increased prenatal exposure to methylmercury are likely to suffer delays in neurological development."

In Grandjean's opinion, two primary points emerge from the Faroe Islands and Madeira findings. "First," he says, "the evidence is accumulating that prenatal methylmercury exposure from seafood may cause subtle neurotoxicity even though current exposure limits are not exceeded. Second," he continues, "the effects on brain function should not be looked at in isolation, as the autonomic nervous system may also be involved, thereby affecting cardiovascular function."

Minority Children at Risk from ETS

Researchers at Columbia University in New York have found new molecular evidence to show that young children are more vulnerable than adults to genetic damage caused by environmental tobacco smoke (ETS). The study was published in the May 1999 issue of *Cancer Epidemiology, Biomarkers & Prevention.* According to the study, cancer risks from ETS to young children and minorities have not been adequately characterized up to this point.

The Columbia researchers attempted to characterize cancer risks further by determining if biomarkers, specific chemicals in the body that have particular molecular features for measuring a disease's progress, are associated with ETS exposure in young children. The study also examined possible ethnic differences in biomarkers. The innovative study, led by Frederica Perera, director of the Columbia Center for Children's Environmental Health, which is funded by the NIEHS, was the first to evaluate ETS's effect on minority groups.

The teams measured four different biomarkers in the blood cells of 109 Hispanic and African-American children, ages 1 to 6. The specific biomarkers measured were cotinine (a metabolite of nicotine), two different carcinogenic protein complexes, and sister chromatid exchanges. This study was the first of its kind to use this set of biomarkers to characterize the cancer risk of ETS in young children

The children studied were divided into three main exposure groups: children with no ETS exposure, children with ETS exposure from a household member other than the mother, and children with ETS exposure via maternal smoking. The results indicated that the four biomarkers increased with ETS exposure in all exposure groups. Says Perera, "Young children and infants *in utero* are likely to be more vulnerable than adults to genetic damage from carcinogens, and carcinogenic exposures during early development can increase the risk of cancer later in life."